

GREEN SYNTHESIS OF SELENIUM NANOPARTICLES VIA MEDICINAL ZAMBIAN PLANTS

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ABSTRACT

The focus of this study was to produce and select promising selenium nano particlessynthesized in combination with medicinal indigenous
Zambian plant extracts. The plants under study were *Bobgunnia
madagascariensis*, *Moringa oleifera*, *Aloe barbadensis*, *Azadirachta
indica*, *Cissus quadrangulari*, *Kigelia Africana*, and *Gliricidia sepium*.
After synthesis the brick red colour change on each sample indicated
the reduction of Se_2O_3 to Se_0 to form green synthesized selenium nano
particles. A total antioxidant capacity analysis was conducted on the
green synthesized selenium nano particles. *Bobgunia madascariensis*,
Moringa oleifera and *Gliricidia sepium* SeNPs were observed to be
promising SeNPs which could be employed in animal nutrition as an
antioxidant defence enhancer.

Keywords: Total Antioxidant Capacities; Selenium Nano Particles;
Plant Extracts.

INTRODUCTION

The use of nanotechnology in this era has proven to be the most promising and advancing field of study due to their wide application in technology and applied science to synthesize materials to a nano scale level. This technology coupled with the use of materials from biological sources has been an emerging and effective technical tool to produce ecofriendly nanoparticles. Herbal or medicinal plants have been utilized for prevention and cure of diseases in many parts of the world for so many years now. These plants are comprised of substances that possess nutritive, preventative, and curative properties for many diseases and deficiencies. Plants are also known to contain various compounds such as alkaloids, flavonoids, phenol, tannin, and alcohol which have the capability to reduce metallic ions to nanoparticles with very good stability. Production of SeNPs using green approaches has been found to consume less energy and possess both simple and broad applications and utilizes a reducing agent that is easily accessible and biodegradable.

MATERIAL AND METHODS

Moringa oleifera, *Azadirachta indica*, *Gliricidia sepium*, *Aloe barbadensis*, *Cissus quadrangularis*, *Kigelia Africana*, and *Bobgunnia madagascariensis* plants were collected and dried in Zambia.

One mL of plant extract was slowly added to 9 mL solution of sodium selenite (10 mM) under continuous stirring on magnetic stirrer. Mixture was covered by parafilm and let react at 22°C, 600 rpm, 24 hr. SeNPs were stored at 4 °C.

For antioxidant capacity, the spectrophotometry ABTS method was used according to standardized protocol.

RESULTS AND DISCUSSION

After incubation the brick red colour change on the right of each sample indicates the reduction of Se_2O_3 to Se_0 to form SeNPs. This can be seen in figure 1, SeNPs formed, their size and shape influenced the interaction with light, causing the absorption of shorter wavelengths and the reflection or transmission of longer wavelengths, particularly in the red part of the spectrum as observed by other research findings on green synthesis of SeNPs^{13,14}. This characteristic red colour serves as a visual indicator and is a result of the collective fluctuation of free electrons on the nanoparticle's surface¹⁴.

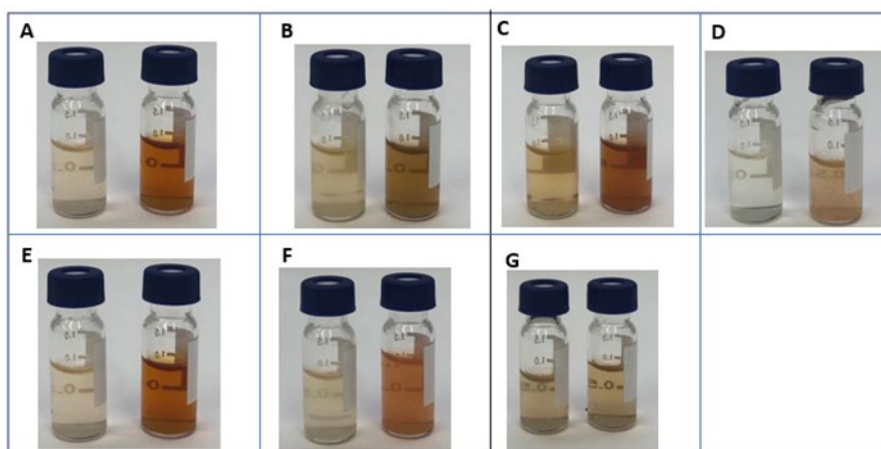


Figure 1: Plant extracts (left) and synthesized SeNPs (right). A) Snake bean, SB (*Bobgunnia madagascariensis*), B) Moringa, M (*Moringa oleifera*), C) Aloe, A (*Aloe barbadensis*), D) Neem, N (*Azadirachta indica*), E) Veld grape, VG (*Cissus quadrangularis*), F) Sausage tree, ST (*Kigelia Africana*) G) Gliricidia, G (*Gliricidia sepium*).

Due to different chemical composition of plant, efficiency of extraction varied based on selected procedure. For the purpose of the study, extraction methods were evaluated based on antioxidant capacity of the extract.

For extraction of SB, the lowest TAC yield was observed with a 1-hour extraction using 30% and 50% EtOH at 60°C; however, after 24 hours, the TAC yield was comparable to other methods. For extraction of M, both 30% and 50% EtOH resulted in higher TAC yields after 24 hours of incubation compared to other extraction approaches. The highest TAC yield for extraction A was observed using H₂O and 30% EtOH at 22°C after just 1 hour. Other extraction methods did not differ significantly in this case. The effect of EtOH concentration and temperature at both time points was observed for extraction N, where higher TAC yields were noted with 30% and 50% EtOH at 60°C compared to H₂O at 22°C and 60°C and 30% EtOH at 22°C. Only at 22°C with 50% EtOH was the TAC yield comparable to extraction with water. The impact of extraction time was significant for extraction VG, where 24-hour incubation showed higher TAC compared to 1-hour extraction. For H₂O at both tested temperatures and 30% EtOH at 22°C, the TAC yield was lower compared to other extraction methods. For extraction ST, the highest TAC was evident at 60°C after 1-hour extraction in H₂O. In EtOH solutions, TAC was lower or comparable to H₂O extraction at 22°C. Conversely, extraction with 30% EtOH at 60°C for 24 hours resulted in significantly lower TAC compared to extraction in H₂O. Extraction in EtOH solutions at 60°C for 24 hours significantly increased TAC compared to extraction in water or after 1-hour extraction for G. Extraction methods for H were comparable in TAC yield, except for a 1-hour incubation in EtOH solutions at 60°C, where the extraction efficiency was significantly lower compared to other methods.

Overall, the highest TAC yields were observed for SB, M, A and VG while the lowest were for N, ST and G, respectively.

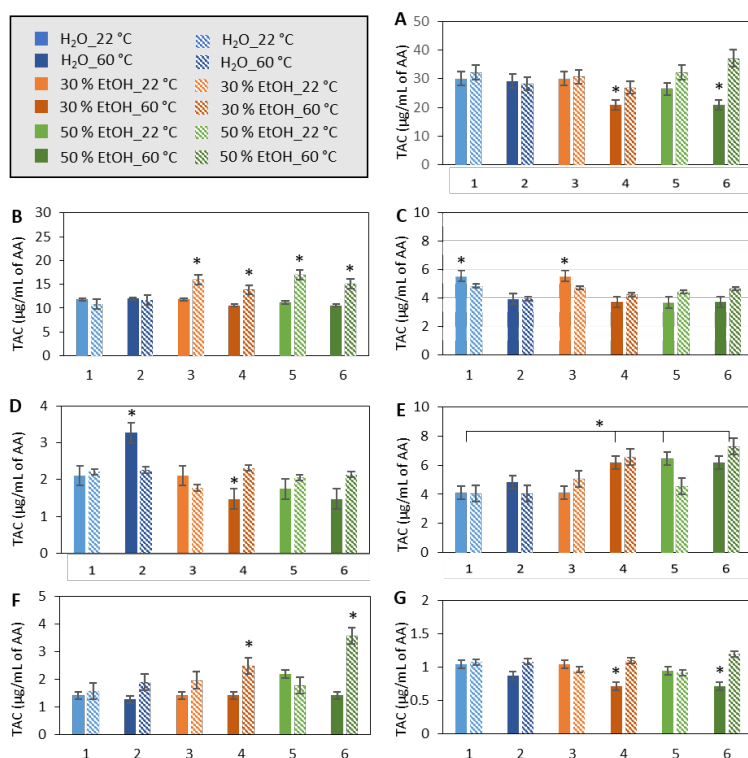


Figure 2: Influence of extraction method on total antioxidant capacity (TAC). TAC is expressed as an ascorbic acid equivalent. A) Snake bean, SB (*Bobgunnia madagascariensis*), B) Moringa, M (*Moringa oleifera*), C) Aloe, A (*Aloe barbadensis*), D) Neem, N (*Azadirachta indica*), E) Veld grape, VG (*Cissus quadrangularis*), F) Sausage tree, ST (*Kigelia Africana*) G) Gliricidia, G (*Gliricidia sepium*).

Total antioxidant capacity (TAC) of SeNPs is shown on Fig. 3. The highest TAC was observed for SB-SeNPs (1500 µg/mL AA equivalent) and for G-SeNPs (948 µg/mL AA equivalent) and the lowest TAC was measured in ST-SeNPs (193 µg/mL AA equivalent).

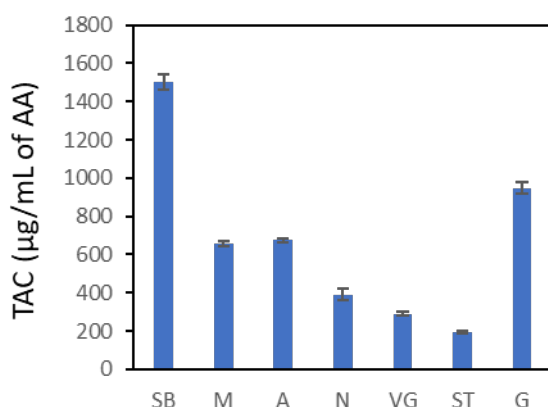


Fig 3: TAC of green synthesized SeNPs

From obtained results is clearly shown that TAC of SeNPs is higher compared to plant extracts. Yields of TAC plant extracts and SeNPs corresponds to each other, however, Girilicia-SeNPs showed higher TAC compared to plant extract. This phenomenon could be explained due to capping agents which are naturally occurred in plant extract and SeNPs formation.

CONCLUSION

Based on findings of this research, SeNPs are stronger antioxidants compared to plant extracts. SB, M and G SeNPs are promising SeNPs which could be employed in animal nutrition as an antioxidant defence enhancer.

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